REMARKS

Introductory Comments:

Claims 1-18 were examined in the Office Action dated December 1, 2004.

Claims 1-4 and 6-8 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 5,973,444 to Xu *et al.*

Claims 5 and 9-18 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Xu *et al.* in view of U.S. Patent No. 6,413,487 to Resasco *et al.*

These rejections are traversed for the reasons discussed below.

Claims 1-18 are presently pending.

Addressing the Examiner's Rejections

Rejections of the Claims Under 35 U.S.C. §103

(A) The Examiner has rejected claims 1-4 and 6-8 under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 5,973,444 to Xu *et al.*

The applicants traverse the rejection. Xu *et al.* discloses carbon fiber-based field emission devices, where carbon fiber emitters are grown and retained on a catalytic metal film as part of the device. Xu et al. disclose that the fibers forming part of the device may be grown in the presence of a magnetic or electric field, as the fields assist in growing straighter fibers. Xu *et al.* does not teach or suggest making carbon nanotubes, growing single-wall carbon nanotubes at a temperature from about 670 °C to about 800 °C, or conducting the reaction at a pressure of about 400 torr to about 600 torr as in the

Applicants' processes. The reference thus does not disclose all the elements of the claimed invention, therefore, it does not make obvious the applicants' invention.

The applicants define single-wall carbon nanotubes (SWNTs), at page 8, line 31 to page 9, line 4, as a molecule formed primarily from sp^2-hybridized carbon atoms bound together in the shape of a hollow tube that is capped at each end. Further, SWNTs are said to be one atomic carbon layer in thickness with a diameter of less than about 3 nm. Xu *et al.* describe the structure of the carbon fiber emitters at column 9, lines 25-61. They state that straight fibers are grown at high temperatures, whereas vermicular fibers, having irregular twisting structures and amorphous structure, are usually produced at temperatures below about 900 °C. Further, the carbon fiber emitters are said to have an average diameter less than about 2-10 microns, most preferably in the range of about 20 nm to about 200 nm. Thus, SWNTs are hollow whereas carbon fibers are solid; SWNTs have defined structure whereas carbon fibers can have amorphous structure, graphite like structure, and herringbone structure; and the diameter of SWNTs (less than 3 nm) is significantly different than the diameter of carbon fibers (20 nm to 200 nm). Thus, the SWNTs produced by the applicants' processes and the carbon fibers disclosed by Xu *et al.* are not the same.

The applicants' processes grow SWNTs at a temperature of about 670 °C to about 800 °C. At this temperature, Xu *et al.* state that vermicular fibers, having irregular twisting structures and amorphous structure would be likely produced. In contrast, the applicants, at page 3, lines 24-34, disclose the advantages of their process is that the production of amorphous material and other side products is minimized at lower temperature, and SWNTs are produced at high yields. Significantly, the applicants state

that outside the preferred temperature range, SWNT yield drops significantly. Applicants' Figure 5 shows that no detectable Raman bands at temperatures less than 670 °C and Raman bands almost disappear at about 1000 °C, indicating SWNTs are not produced at these temperatures. The conclusion is further supported by TEM images shown in Figures 1 and 2. In contrast, Xu *et al.* at column 9, lines 6-13, state that their temperature range is from about 300 °C to about 1200 °C. The applicants' data clearly shows that SWNTs are not produced through out the temperature range disclosed by Xu. Therefore, the process of Xu that produces vermicular fibers having irregular twisting and amorphous structure can not be used to make SWNTs.

Finally, at column 8, lines 61-63, Xu *et al.* disclose that the carbon source can be from one millitorr to several atmospheres. However, they do not teach or suggest that SWNTs can be synthesized across such a large range of pressures. At the time of the invention, the applicants were not aware of any publication that disclosed SWNTs could be produced across such a large range of pressures. Even Xu *et al.*'s carbon fibers are produced at very low pressures, as shown in Examples 1 and 4. At column 19, lines 62-65, (Example 1), the substrate is heated at various temperatures and pressures, and for various periods of time. The range of pressures employed is 0.1-1 torr of acetylene – this pressure is significantly lower than the pressure of about 400 torr to about 600 torr claimed by the applicants. Further, at column 21, lines 64-65 (Example 4) Xu *et al.* states that "the wafer was heated in 200 millitorr of acetylene at 650° C for about one minute." Thus, even though the pressure of the carbon source can cover a large range of pressure, the specific examples utilize pressures that are dramatically lower than the pressures

utilized by the applicants, thereby teaching away from the specific ranges claimed by the applicants.

The reference does not teach or suggest the synthesis of SWNTs, the advantages provided by the applicants, or the use of pressure in the particular range of about 400 torr to about 600 torr. The Examiner is therefore respectfully requested to withdraw the rejection.

(B) The Examiner has rejected claims 5 and 9-18 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Xu *et al.* in view of U.S. Patent No. 6,413,487 to Resasco *et al.* Resasco is said to teach the use of bimetallic catalysts containing at least one of a Group VIII metal and one of a Group VIb metal, and a catalyst made up of more than one Group VIII metal and a single Group VIb metal.

The applicants traverse the rejection and supporting remarks as the references cited by the Office do not teach or suggest the claimed invention. The combination of Xu *et al.* and Resasco *et al.* does not teach or suggest conducting the reaction at a pressure of 400 torr to about 600 torr as in the Applicants' processes. In fact, Resasco *et al.* teach or suggest a method of preparing carbon nanotubes under high or elevated reaction pressures that range from about 1 atmosphere to about 40 atmospheres (column 4, lines 11-15). Resasco *et al.* does not provide the elements missing from Xu *et al.* discussed in detail above. Thus, the combination of the cited references do not disclose all the elements of the claims. The Examiner is therefore respectfully requested to withdraw the rejection.

CONCLUSION

Applicants respectfully submit that the claims define an invention that is patentable over the art. Accordingly, a Notice of Allowance is believed in order and is respectfully requested.

If the Examiner notes any further matters which the Examiner believes may be expedited by a telephone interview, the Examiner is requested to contact the undersigned.

Respectfully submitted,
Grigorian *et al.*

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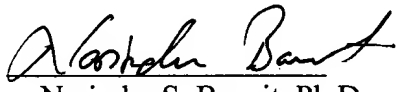
By: 

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